the cephalic index from two measures of length and breadth of the head.

MESSRS. GINN AND CO. announce the forthcoming publication of "A Laboratory Manual in Astronomy," by Mary E. Byrd. The manual is designed as a handbook of laboratory instruction to accompany the study of elementary and general astronomy in secondary schools and colleges. The same firm announces a college text-book of "Physics," by Profs. Charles S. Hastings and Frederick E. Beach.

THE zoological material collected by Dr. Arthur Willey from New Britain, New Guinea, Loyalty Islands, and elsewhere, during his expedition in search of the eggs of the Pearly Nautilus, is being studied by a number of distinguished zoologists, and the first two parts of a work containing the results have been published by the Cambridge University Press. It is expected that five or six similar parts will be issued; and we defer our notice of the work until all of them have been published.

THE density of liquid air is the subject of an interesting paper by Prof. A. Ladenburg and Dr. C. Krügel, in the current number of the *Berichte*. The hydrostatic method with a Westphal balance was employed. It is pointed out that a determination of the density of liquid air obtained in the usual way is of little value unless accompanied by a determination of the exact composition of the mixture, since, as is well known, after standing some time, the residual fluid is nearly pure oxygen. In these experiments, the whole of the liquid was allowed to evaporate into large gasholders, and the gaseous mixture analysed. From these results, the authors calculated that the density of normal liquid air containing 20·9 per cent. of oxygen would be ·871. It was found that the density of the liquid containing 93·6 per cent. of oxygen was higher than that of pure oxygen. It is suggested that this may be due to carbon dioxide or krypton.

CONSIDERING its exceptional behaviour with respect to hydrogen, the metal palladium has not hitherto been used to the extent that would have been expected as a reducing agent in organic chemistry. The mode of application of palladium, however, described by Dr. N. Zelinsky in the current number of the *Berichte*, would appear to promise a more extensive use of this metal. A zinc-palladium couple is prepared from zinc and palladium chloride, in a manner similar to the well-known zinc-copper couple. This is placed in alcohol, and acid added until hydrogen gas just commences to be evolved. At this stage the palladium black is saturated with hydrogen, and produces energetic reduction of the alkyl iodide or bromide, the acid and iodide being now added alternately. Hexamethylene, and the ethyl and methyl-hexamethylenes, which are obtained with great difficulty from their halogen derivatives by ordinary reducing agents, are produced in yields of 70–75 per cent. of the theoretical, when the corresponding iodides or bromides are treated in this way.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, presented by Miss K. M. Burne; a Green Monkey (*Cercopithecus callitrichus*, ♂) from West Africa, presented by Mr. F. W. Coker; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Miss A. M. Deeks; a Black-headed Lemur (*Lemur brunneus*, ♂) from Madagascar, deposited; a Tui Parrakeet (*Brotogerys tui*) from Brazil, an Uvæan Parrakeet (*Nymphicus uvaensis*) from the Island of Uvea, Loyalty Group, three Common Crowned Pigeons (*Goura coronata*) from New Guinea, purchased; two Barnard's Parrakeets (*Platycercus barnardi*) from South Australia, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY:—

February 10.	19h. Venus at greatest elongation 46° 46′ west. This planet rises nearly three hours before the sun, and presents a brilliant appearance in the south-east sky.
10.	Date of computed perihelion passage of Denning's comet (1881 V.).
11.	10h. 39m. Minimum of Algol (β Persei).
12.	7h. 35m. to 8h. 28m. Occultation of the star 19 Piscium (mag. 5·2) by the moon.
14.	Mars. Illuminated portion of disc 0·969.
14.	Venus. ,, ,, ,, 0·517.
14.	7h. 28m. Minimum of Algol (β Persei).
15.	Jupiter. Polar diameter 35″·8. The planet rises at midnight, and is favourably visible afterwards.
16.	15h. 45m. to 17h. Transit of Jupiter's Sat. III.
18.	8h. 53m. to 10h. 11m. Occultation of the star 103 Tauri (mag. 5·5) by the moon.
24.	Saturn. Outer minor axis of the outer ring = 16″·82. Polar diameter 15″. The planet may be well seen as a morning star.

HARVARD COLLEGE OBSERVATORY.—In the fifty-third annual report of this well-known observatory, Prof. Pickering, the director, again chronicles the completion of an enormous amount of work. With the east equatorial (15-inch), under the charge of Mr. O. C. Wendell, about 25,000 photometric light comparisons have been made, chiefly with the new polarising photometer with achromatic prisms. This instrument was also used in the photometric measurement of Jupiter's satellites while undergoing eclipse.

Similar photometric comparisons of variable stars, to the number of about 1650, have been made with the west equatorial (6-inch). These observations are now reduced and will shortly be published. In addition, comparison stars have been selected for sixty other variables, and the co-operation of other astronomers in following up the stars when too faint for the 15-inch is invited, for which purpose charts and lists of the stars in question will be furnished on application.

The reduction of the observations of fundamental stars with the meridian circle, by the late Prof. Rogers, were incomplete at the time of his death, and are still therefore under discussion.

With the meridian photometer the observations have been made by the director. Extending over 152 nights, the number of settings has been 73,684. This completes the work that was planned in 1892 for this instrument, and it is proposed to send it to Arequipa next spring, to revise the contents of the Southern Harvard Photometry.

Photometric observations of faint stars have also been commenced by the director using a 12-inch telescope mounted horizontally, and having a Welsbach burner for artificial comparison.

In connection with the spectroscopic work of the Henry Draper Memorial, 2192 photographs have been taken with the 8-inch telescopes. By the examination of these and other plates taken with the Bruce and Bache telescopes, Mrs. Fleming has detected twelve new variable stars, six of which showed *bright* hydrogen lines; nine stars have spectra of the fourth type, seventeen of the fifth, and ten objects are catalogued as gaseous nebulæ. In three known variables—V Tauri, U Cancri, T Capricorni—the hydrogen lines have been found bright.

With the 11-inch Draper telescope 873 plates have been taken, and a photograph of α Canis Majoris obtained at mid-day under conditions rendering it probable that bright stars could be thus usefully photographed when in transit.

Photographs of stars near the pole have been taken with the 15-inch reflector, with the object of accurately determining the constants of aberration, precession, and nutation.

The examination of the photographs of star clusters for variables has been continued, resulting in the detecting of 509 stars of this type. The most notable occur in the clusters ω Centauri, Messier 3, Messier 5, and Messier 15.

With the Bruce photographic doublet, photographs have been obtained which, with three and four hours' exposure, show no distortion of the star images, and Prof. Turner reports favourably on the freedom from distortion over an area of 4° × 4°. Both chart plates and stellar spectra have been taken with this instrument.

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HARVARD ASTROPHYSICAL CONFERENCE.—Several items in the report of this conference have already been noticed, but in the pamphlet now distributed by Prof. M. B. Snyder, of the Philadelphia Observatory, there are some points of interest.

Mrs. Fleming presented a paper on stars of the Vth type in the Magellanic clouds. These stars have spectra consisting chiefly of bright lines, and are usually known as Wolf-Rayet stars. Up to 1897 the number of these objects known was 67, and all lie closely along the central line of the Milky Way. Photographs taken at Arequipa with the Bruce telescope revealed 21 of these objects in the large Magellanic cloud, 3 others in the Milky Way, and 1 in the small Magellanic cloud, bringing the total number up to 92. Of these fifth-type stars 22 are thus in the Magellanic clouds, and this large proportion renders probable the connection of these objects with the Milky Way.

Mr. E. S. King described an ingenious method of converting prismatic spectra into normal spectra. To do this the original plate is inclined to the plate on which the copy is to be made, by an amount calculated to make the scale exact for three points in its length, while at the same time maintaining good focus. As illustrations he showed several stellar spectra compared with Rowland's map of the solar spectrum. Prof. Pickering said that the method was perfectly general, and all scales were thus reproducible.

Mrs. Fleming, in a paper on classification of spectra of variables of long period, describes the characteristics of these objects. About 100 stars of this class are known, and all have the hydogen lines bright. Examination of the relative intensities of these lines has led to the class being divided into eleven groups, of which two are mentioned in detail. One group, represented by R Lyncis, has a spectrum resembling α Tauri, but having Hβ and Hγ strongly bright, while Hδ is barely visible. Another group, typified by R Leonis, shows a continuous spectrum with Hβ invisible, Hγ barely visible, and Hδ strongly marked.

Prof. G. E. Hale presented a review of work on the spectra of stars of Secchi's fourth type. These are the blood-red stars, and the spectra of twenty-two of them have been obtained with the spectrograph of the 40-inch Yerkes telescope, mostly with a dispersion of one prism. For the two brightest stars of this class, 132 and 152 Schjellerup, three prisms were employed. The photographs show a large number of lines hitherto unrecorded, most of which are dark; but it is stated that there seem to be a number of bright lines.

The presence of bright lines in 152 Schjellerup was, it is stated, confirmed by Profs. Keeler and Campbell at the Lick Observatory. The wave-lengths of two of the brightest of these lines agree very closely with those of the two brightest lines in the Wolf-Rayet stars, as measured by Campbell; but no connection between these two classes of bodies is yet indicated. A reproduction of the photographed spectrum of 152 Schj. is published in the *Ast. Phys. Journ.*, November 1898.

THE PLAN OF THE EARTH AND ITS CAUSES.[1]

IN a passage in the "Novum Organum" Bacon pointed out resemblances between the continents of the Old and New Worlds, which he thought showed that their shapes were not due to chance, but to the action of a common cause. Similar coincidences have been repeatedly noticed by geographers, who have accordingly been led to the belief that the distribution of land and water on the globe is based on a definite plan. Any such plan can only be recognised in broad outline, since geographical shapes depend on an intricate series of local accidents. Topographical form depends on such inconstant, incalculable factors that the stages of its growth are often untraceable. The missing links of geographical evolution are as numerous as those of organic evolution. Nevertheless, belief in the existence of a fundamental geographical plan is as old as geography. It was expressed in some of the earliest classical maps; it possessed the minds of mediæval cartographers, and led to their fantastic wheel maps; and it was popularised in the first half of the present century by the teaching of Humboldt and Élie de Beaumont. But with the growth of Lyellism and its doctrine of the interchange of land and sea under the influence of local variations in level, the idea fell into discredit.

But the discoveries of oceanography and geology have shown what allowances should be made for the obscuring action of minor oscillations, and thus have revealed fresh geographical homologies and explained apparent exceptions. The introduction of such local changes is, however, unnecessary, since the existence of a geographical plan of the earth is shown by three features: (1) the concentration of land in the northern, and of water in the southern hemisphere; (2) the triangular form of the geographical units, and the southward tapering of the land masses. From these two features it follows that there is a "northern land belt" from which three continents project southward, separated by three oceans, which expand until they form a "southern ocean belt." The third feature is the antipodal position of oceans and continents. The main problem of geomorphogeny is the explanation of these three facts.

The question is simplified by remembering that the earth consists of three parts: (1) the unknown internal centrosphere; (2) the rocky crust, or lithosphere; (3) the oceanic layer, or hydrosphere. Oceans and continents occupy, respectively, depressions and elevations of the lithosphere; and their distribution, therefore, directly depends on the distribution of the irregularities in its surface. If the existing irregularities have remained unchanged throughout geological time, then the problem is astronomical rather than geographical and geological.

The attempts to solve the problem on the basis of the permanence of the main geographical features may be grouped into four sets: (1) Prof. G. H. Darwin has attributed the main geographical lines to tidal wrinkles in the viscous crust; (2) Prinz has assigned them to torsion due to the acceleration of the equatorial and southern belts of the earth, and retardation of the northern land belt; (3) Sir J. Lubbock and Prof. Lapworth have independently explained continental form as due to the intercrossing of two sets of folds, one parallel to the equator and one at right angles to it; (4) Lord Kelvin refers back the main geographical divisions to an even earlier period than the previous theories; for he regards them as due to shoaling in the last molten layer of the globe, over areas determined by previous chemical segregations in the nebula. These theories are not necessarily inconsistent with the asymmetry between the northern and southern hemispheres; the primitive wrinkles, the double folds, and the nebulous segregations are each in harmony with a considerable amount of geological evidence; but the theories are geographically inadequate, because they do not explain how the existing asymmetry has been developed. To do this, some more continuously acting cause is required, such as the secular contraction of the earth, on which Élie de Beaumont based his famous theory. His system, however, regarded the world as symmetrical, and was too rigidly geometrical to apply satisfactorily to a heterogeneous globe. In his "pentagonal réseau" antipodal areas were similar; for he regarded the world as a spheroid based on a pentagonal dodecahedron, which is a holodedral form; whereas, owing to the dissimilarity of antipodes on the earth, the lithosphere may be better regarded as hemihedral. The recognition of this fact led to the great advance on Élie de Beaumont's theory made by Lowthian Green, which has been advocated by de Lapparent and Michel-Lévy.

The tetrahedral theory does not regard the world as a regular tetrahedron; but suggests that, owing to the collapse of the earth's crust due to contraction, the lithosphere has undergone a tetrahedroid deformation. That collapsing shells tend to become tetrahedral, just as short tubes often collapse trigonally, is shown by experiments. "Nothing," says E. D. Preston, "is more in accordance with the action of physical laws than that the earth is contracting in approximately a tetrahedral form. . . . Experiments on iron tubes, on gas bubbles rising in water, and on rubber balloons, all tend to bear out the assumption that a homogeneous sphere tends to contract into a tetrahedron."

If such be the case, then the lithosphere would be depressed on four faces, which, being lower, would be naturally occupied by oceans; while the four projecting coigns would stand up as continents. In such a tetrahedrally deformed earth there would be a central ocean (the Arctic) on one face surrounded by a land belt, from which three meridional continents would run southward; they would each taper to a point, below which would be a southern ocean belt, from which three oceans would project northward. South of the ocean belt would be an Antarctic continent.

The arrangement of land and water on such an ideal, de-

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[1] Abstract of lecture to the Royal Geographical Society on January 23, by Dr. J. W. Gregory.

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